Brain Computer Interface: Implementation and Applications

[1] Seemant Singh, [2]Sharayu Barwe, [3]Niraj Bhosale ,[4]Tanmay Shendkar, [5]Shilpa Bhosale,

[1,2,3,4,5]*Student, Department of Computer engineering, NBNSSOE, Maharashtra, India*

ABSTRACT

A brain computer interface, which is likewise known as an neural-manage interface, direct neural interface is an instantaneous conversation pathway between an improved or stressed brain and an external tool. Mind studying and remote communication have their precise fingerprint in numerous fields along with instructional, self-law, production, advertising, security as well as games and enjoyment. It creates a mutual information between customers and the encompassing structures. This paper indicates the implementation elements of the tool as well as the applications. The main device i.e. EEG is also explained well in the paper to understand the BCI from very basic level. The review paper also shows the algorithms that can be used in this BCI and machine learning platform development. Different solutions that aim to limit and decrease their effects have also been represented.

Keyword *BCI, EEG, non-invasive, classifications, electrodes, gaming and entertainment, mind control.*

1. Introduction

A brain computer interface (BCI) which is also referred as a brain device interface (BMI), is a hardware and software program communications device that facilitates people to engage with their environment, without the involvement of peripheral nerves and muscular tissues, by using the usage of control signals generated from electroencephalographic device. A BCI is an artificial intelligence device that can apprehend a positive set of styles in brain signals following 5 consecutive degrees: signal acquisition, pre-processing or signal enhancement, feature extraction, classification, and the manage interface the signal acquisition level captures the mind alerts and may also perform noise reduction and artifact processing. The pre-processing stage prepares the indicators in a suitable form for further processing. The function extraction stage identifies discriminative information inside the mind indicators which have been recorded. The extraction of this thrilling records is a very tough challenge. Brain signals are mixed with different signals coming from a finite set of mind sports that overlap in both time and area. The function vector must also be of a low measurement, to reduce feature extraction degree complexity, without a relevant data loss. Sooner or later the manipulate interface stage interprets the labeled alerts into meaningful commands for any related tool, inclusive of computer.

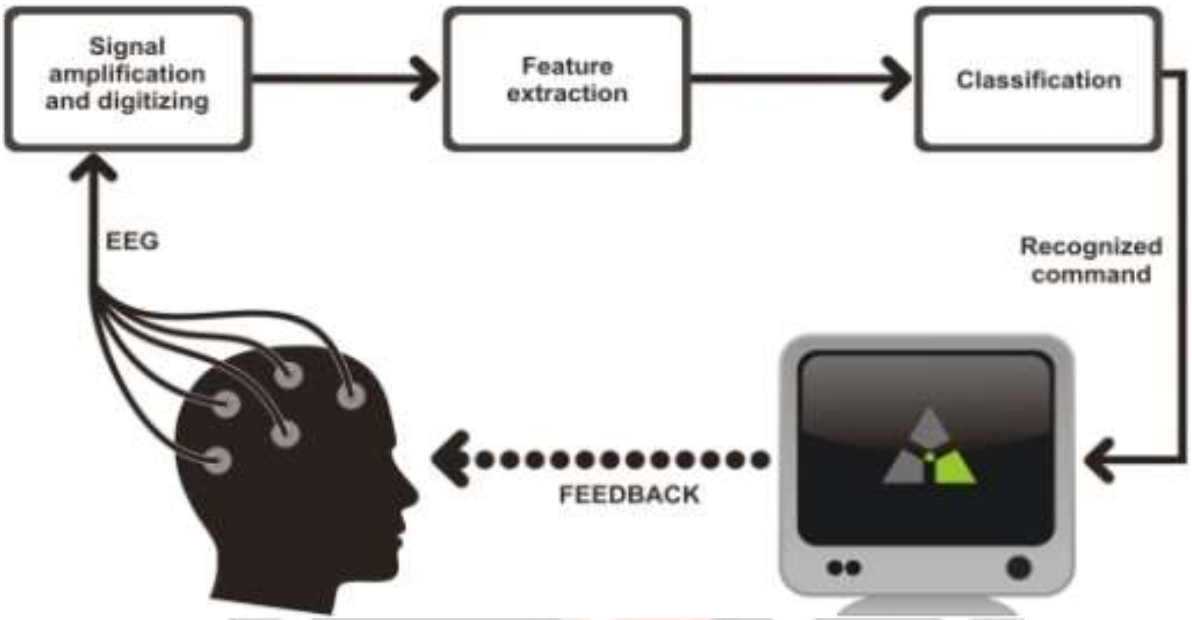

Fig-1BCI component and stages

2. Literature Survey

Sr. no	Year	Title	Author	Proposed system	Drawbacks
1	2015	Mind guided motion control of robot manipulator using EEG signals	Antoni MalkP, Chenguang Yang, Ning Wang!, and Zhijun Li2	-How EEG can be acquired through headset. -OpenViBE platform to Process EEG	-The p300 speller could be improved and adapted to get better and faster results. -More robot control possibilities are not better, and the functionality can be further enriched.
2	2015	Brain computer interface: control signals reviews	Rabie A. Ramadan, Athanasios V. Vasilakos	-Detailed phase description -Up-to-date BCI algorithms and techniques for all phases	-Comparisons and classification of signals is not effective. -problem of noise reduction is not solved well

3	2015	2015: Brain-Computer Interface Technology and Development: The emergence of imprecise brainwave headsets in the commercial world.	Narisa N.Y. Chu	-brain signal processing algorithmic approach in achieving the level of interpretability of brain signals -standardize the brain signal databank, anticipating its reach to big data	-algorithms are not more accurate -implantations of headsets is not comfortable
4	2012	Brain computer interface: Review	Luis Fernando Nicolas-Alonso* and Jaime Gomez-Gil	-provide communication ways to disabled people -Determination of users intention	-invasive methods need more clarification -information bit rate is low
5	2015	Brain computing interfacing: applications and challenges	Sarah N.Abdulkader, AymanAtia,Mostafa-Sami M.Mostafa	-use of BCI in games and entertainment -creation of mutual understanding between user and surrounding system	-training challenges -non-linearity -information transfer rate -noise
6	2013	EEG-Based Brain-Computer Interfaces: A Thorough Literature Survey	Han-Jeong Hwang a , Soyoun Kim b , Soobeom Choi a & Chang-Hwan Im a	-BCI paradigms -target applications -feature types -classification algorithm	-brain complexity is not solved well -algorithms and feature classifications should be more precise

3. Proposed System

3.1 EEG Device

EEG is a non-invasive manner to inspect mind. EEG measures electric mind interest resulting from the float of electric currents at some stage in synaptic excitations of the dendrites in the neurons and is extraordinarily sensitive to the results of secondary currents. EEG alerts can be effortlessly recorded through electrodes located on the scalp. The EEG recording machine consists of electrodes, amplifiers, A/D converter, and a recording tool.

The EEG recording machine consists of electrodes, amplifiers, A/D converter, and a recording tool. The electrodes gather the signal from the scalp, the amplifiers system the analog signal to extend the amplitude of the EEG signals in order that the A/D converter can digitalize the signal in a extra correct manner. In the end, the recording tool, which can be a personal laptop or comparable, stores, and displays the facts. Electrodes are commonly fabricated from silver chloride. Electrode-scalp touch impedance have to be among 1Ω and 10Ω to record an accurate signal.

The electrode-tissue interface isn't simplest resistive however also capacitive and it consequently behaves as a low skip filter out. EEG gel creates a conductive course among the skin and every electrode that reduces the impedance. Use of the gel is cumbersome, however, as persisted maintenance is needed to guarantee a tremendously top pleasant sign. The waves we will be most without difficulty capable to distinguish are alpha and beta waves -- alpha waves arise at round 8-12 Hz and when measured from the frontal lobe provide an estimate of how at ease a person is, at the same time as beta waves are around 12-30 Hz and correspond to how someone is concentrating or how alert they may be.

3.1 Software

When the hardware is completely prepared, person can put the electrodes at the scalp as a way to get the mind wave indicators as an enter. These signals could be then processed within the device built. For further processing, i.e. to expose these indicators at the laptop display we require the software program component. This system evolved at the start degree may be sincerely only a records acquisition/ visualization one.

Even if desktop is capable of get the mind waves as an input, these alerts will now not be repetitive. For this reason, a system studying platform is developed with a purpose to be easy to classify the ones alerts the use of a quality perfect algorithm. So the type step could be very vital to recognize the user's intentions. Regression or type algorithm can help to gain this purpose however presently, classification is the maximum famous method.

Type algorithms have traditionally been calibrated via customers thru supervised learning the use of a labeled data set. It is assumed that the classifier is able to locate the patterns of the brain signal recorded in on line classes with feedback.

3.2 Classification algorithm

The motive of the classification step in a BCI system is recognition of a user's intentions on the basis of a feature vector that characterizes the brain activity provided by the feature step. Classification algorithms can be developed via either offline, online or both kinds of sessions. The offline session involves the examination of data sets, such as BCI competitions data sets which are collected from an adaptive or closed-loop system.

The feature vector is low (two) dimensional, that's why good classification results can be obtained with simple algorithms. The KNN algorithm is one of the simplest algorithms to classify objects in machine learning. All feature vectors which are extracted from the sub-training set are located in the feature space. A feature vector which belongs to the test data is then classified with the class of the majority of the k-nearest neighbors among all the located feature vectors. The performance of a nearest neighbor classifier depends on the distance metric and the value of the neighborhood parameter k, which controls the volume of the neighborhood. The most common choice for the distance function is the Euclidean metric. The KNN algorithm is really very sensitive to the local distribution of feature vectors. EEG signals are naturally non-stationary, subject-specific, distorted by various artifacts like EMG and EOG, that's why this kind of information is usually not available. Consequently, the neighborhood parameter must be estimated from the training data at hand by using a heuristic technique. The cross-validation technique described above can be used to select the optimal neighborhood parameter that yields the highest accuracy rate for the test data. The k-nearest neighbors (KNN) algorithm finds the k nearest neighbors among the training set, and the categories of the k-nearest neighbors are used to weigh the category candidates. The performance of this algorithm greatly depends on two factors: a suitable similarity function and an appropriate value for k. If k is too large, big classes will overwhelm the small classes whereas if k is too small, the advantage of KNN algorithm cannot be traced.

4. Applications

The main target populations for BCI packages fall into 3 categories. The primary group consists of complete Locked-In nation (CLIS) sufferers who have misplaced all motor manage, due to the fact they'll be at a terminal degree of ALS or suffer severe cerebral palsy. The second one organization incorporates Locked-In country (LIS) patients who are nearly absolutely paralyzed, however with residual voluntary movement, along with eye movement, eye blinks, or twitches with the lip. The third organization of ability BCI customers includes abled bodied humans and people with giant neuromuscular manage, especially speech and/or hand manage.

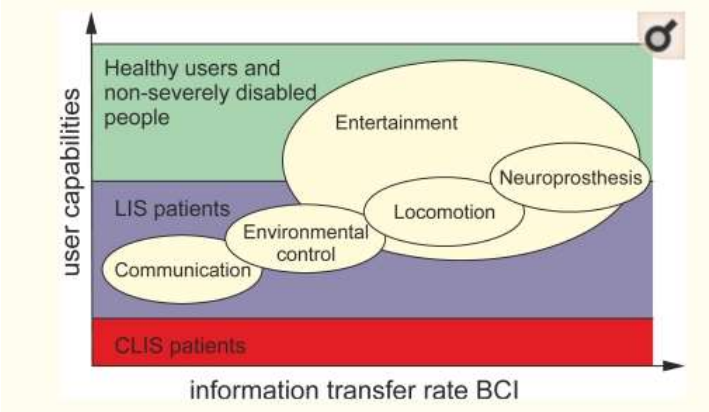

Fig 2-BCI applications

Nowadays, there are a considerable variety of very different BCI packages, which includes word processors, tailored net browsers, mind manage of a wheelchair or neuroprostheses, and games, amongst others. But, maximum packages have completely been designed for education or demonstration purposes.

Leisure-orientated BCI programs have commonly had a lower precedence in this discipline. Till now, research into BCI generation has generally focused on assistive packages, inclusive of spelling gadgets, wheelchair control or neuroprostheses rather than applications with enjoyment purposes. Leisure-orientated BCI programs have adapted very well-known video games inclusive of Pac-man, Pong and comparable games so that they'll be played thru motor imagery.

Here the game of ping pong is advanced to expose the primary running of BCI where you manipulate the paddles together with your concentration of alpha waves. The very best way to manipulate the controls is to shut your eyes and loosen up to make the paddle circulate up, and to open your eyes and attention to make it move down.

5. Future scope

The facts switch charge provided by BCIs is simply too low for herbal interactive communication, even for experienced topics and nicely-tuned BCI systems.

the excessive mistakes charge in addition complicates the interaction.

BCI systems cannot be used autonomously by u (D.S. Tan, 2010)sing disabled people, because BCI systems require assistants to use electrodes or signal-receiving gadgets earlier than the disabled individual can talk.

A BCI user can be capable to turn the BCI gadget off by means of brain pastime as input, but generally can't flip it again on once more, that is termed the “Midas touch” hassle dealing with BCI applications demands a high cognitive load which could normally be carried out by way of users in quiet laboratory environment, however not inside the actual global.

6. Conclusion

This above paper indicates the details of mind computing interface and how it may be very useful if programs for real life may be evolved. It additionally suggests the hardware and software development of a small device and related software so as to reveal how BCI can be an open source platform the use of machine learning. Various programs and challenges are also given inside the paper. Those challenges can be overcome with time the use of extra advanced software as well as hardware answers. The achievements and the ability for brand new BCI packages have manifestly given a great raise to BCI research concerning multidisciplinary scientists e.g., neuroscientists,

engineers, mathematicians, and medical rehabilitation professionals, amongst others. Interest in the BCI discipline is predicted to increase and BCI design and improvement will in all opportunity hold to carry blessings to the daily lives of disabled people.

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